

# **FRED Reports**

**SURVIVAL, TIMING, AGE, SIZE, AND  
HARVEST OF CHUM SALMON RETURNING  
TO HIDDEN FALLS HATCHERY IN 1984**

by  
**John A. McNair**  
Number 52



**Alaska Department of Fish & Game**  
Division of Fisheries Rehabilitation,  
Enhancement and Development

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## ABSTRACT

About 600,000 adult chum salmon, *Oncorhynchus keta*, returned to Hidden Falls Hatchery in 1984, of which 550,000 were estimated to be caught in commercial seine fisheries. One hundred fifty-one different boats participated in the July fisheries. Spawning at the hatchery began a week later than usual; 35 million eggs were taken for the 1984 brood. Sex ratios, coded-wire tag retention rates, and numbers of salmon returning to the rack were determined for each age class.

The survival rate for the 1979 brood was estimated to be 4.85% from fry to adult. The survival estimate for the 1980 brood was 6.20%, not including the age-0.4 component returning in 1985.

Coded-wire tag returns showed that saltwater-reared chum fry survived almost twice as well as freshwater-reared fry. The former were significantly heavier at release than the latter. No difference was seen when comparing brood sources. Marked adult salmon produced by the 1980 brood and released as juveniles in mid-May survived six times better than those released in April. A similar tagging scheme for the 1981 brood (0.2 component) showed only a slight favoring of the fry that were released later.

Key Words: Hidden Falls Hatchery, chum salmon, *Oncorhynchus keta*, survival, age, length, sex, and harvest.

## INTRODUCTION

Hidden Falls Hatchery is a state-owned facility that has been operated by the Alaska Department of Fish and Game, Division of Fisheries Rehabilitation, Enhancement and Development (FRED) since 1979. The remote hatchery is located in Southeast Alaska, about 30 km east of Sitka on Baranof Island.

At full capacity Hidden Falls Hatchery will release 55 million chum salmon, *Oncorhynchus keta*, fry annually; each year this will result in the return of 845,000 adult salmon. Broodstock development began in 1977; chum salmon eggs were taken primarily from Kadashan River in Tenakee Inlet. Adult chum salmon began returning to Hidden Falls in 1981. The numbers of returning fish increased rapidly, enabling Hidden Falls to be independent of taking eggs from remote streams by 1982. About 135,000 adult chum salmon returned to Hidden Falls Hatchery in 1983, of which 82,600 were estimated to have been caught by the commercial seine fishery (McNair 1985). This report summarizes our evaluation of the salmon returning to Hidden Falls Hatchery in 1984.

## METHODS

### Incubation, Fry Tagging, and Fry Release

Hidden Falls Hatchery spawning procedures, incubation techniques, and fry rearing and release methods are discussed in detail by Cochran and Smith (1984). To evaluate the adult run of hatchery-produced salmon, each year a representative sample of fry to be released was marked by adipose clip excision and half-length coded-wire tag insertion (CWT), according to Moberly et al. (1977).

### Broodstock

All fish killed at the spawning rack were inspected to see if their adipose fin had been clipped. Clip quality of each marked fish was quantitatively graded. A value of one was assigned to fish whose adipose had been smoothly and obviously excized at its base; a value of two, to a fish whose adipose fin was not smoothly and obviously removed. Lengths and multiple scale samples were taken from all adipose-clipped chum salmon. Heads from marked fish were removed, and a numbered cinch tag was attached to each one. The heads were frozen for later transport to the FRED Tag Recovery Lab in Juneau. During daily spawning operations, 80 to 120 scale samples were taken from randomly selected adults; the sex of these random selections was alternated daily. Lengths (mideye to fork of tail) were measured periodically from these sampled fish. All appropriate data were entered on sampling forms for later entry into a data bank. Fish were aged with the European method. Five-year-old chum salmon were called 0.4; four-year-old chum salmon, 0.3; and three-year-old chum salmon, 0.2.

### Commercial Fisheries

Names of seine boats participating in terminal-harvest fisheries at Hidden Falls were logged daily by biologists and hatchery staff from a small outboard skiff. Weekly estimates of harvested salmon were made by the Division of Commercial Fisheries (Comm. Fish.), area management biologist, Bob DeJong, using preliminary tender reports. These in-season catch numbers were confirmed later by fish-ticket summaries. Fish quality was appraised by interviewing fishermen and processors. A percentage of boats fishing at Hidden Falls was sampled for marked fish by staff from Comm. Fish., Stock Biology Group. These port samplers also took representative scale samples from each fishery to estimate age-class distribution of harvested hatchery salmon.

## RESULTS AND DISCUSSION

### Commercial Fisheries

Traditional commercial purse-seine openings were supplemented with four major terminal fisheries in Kasnyku Bay in 1984. The dates fished were 1 July, 8 and 9 July, 15 and 16 July, and 22 and 23 July. Summaries of fish tickets showed that over 551,000 chum salmon were caught in Kasnyku Bay during this period. At least 151 different seine boats fished for Hidden Falls Hatchery adult salmon over the season; a maximum of 123 boats fished on 8 July. Fish quality was good to excellent; there were large percentages of brights and semibrights early in the season. The area fished was between South Point, the southern entrance to Kelp Bay, and Point Turbot, the northern entrance of Takatz Bay (Figure 1). This area was smaller than that fished in 1983, and incidental wild pink salmon interception was significantly reduced as a result (R. DeJong, personal communication). Age distribution of the commercially caught salmon averaged 2% 0.2, 90% 0.3, and 8% 0.4 for both sexes combined.

A major plankton bloom occurred on 19 July, which was a few days before the last terminal fishery in the bay. Horizontal zooplankton tows were conducted, but because the most abundant plankter was smaller than the 243- $\mu$ m net mesh used, it was not identified. The intense bloom lasted several days and evidently drove most of the hatchery salmon out of Kasnyku Bay into Chatham Straits. Many thousands of fish could be seen jumping in the bay in the morning of 19 July, and by noon all the fish had scattered. Accordingly, effort by seiners was less efficient.

Kasnyku Bay was opened on 13 August to allow for the harvest of excess dark chum salmon. Only one seine boat fished, catching about 1,000 fish. By mid-August, all the fish had ceased roaming the shoreline, had "locked in" on the fresh water, and once inside the net-pen inlet, had become inaccessible to the seine boats.



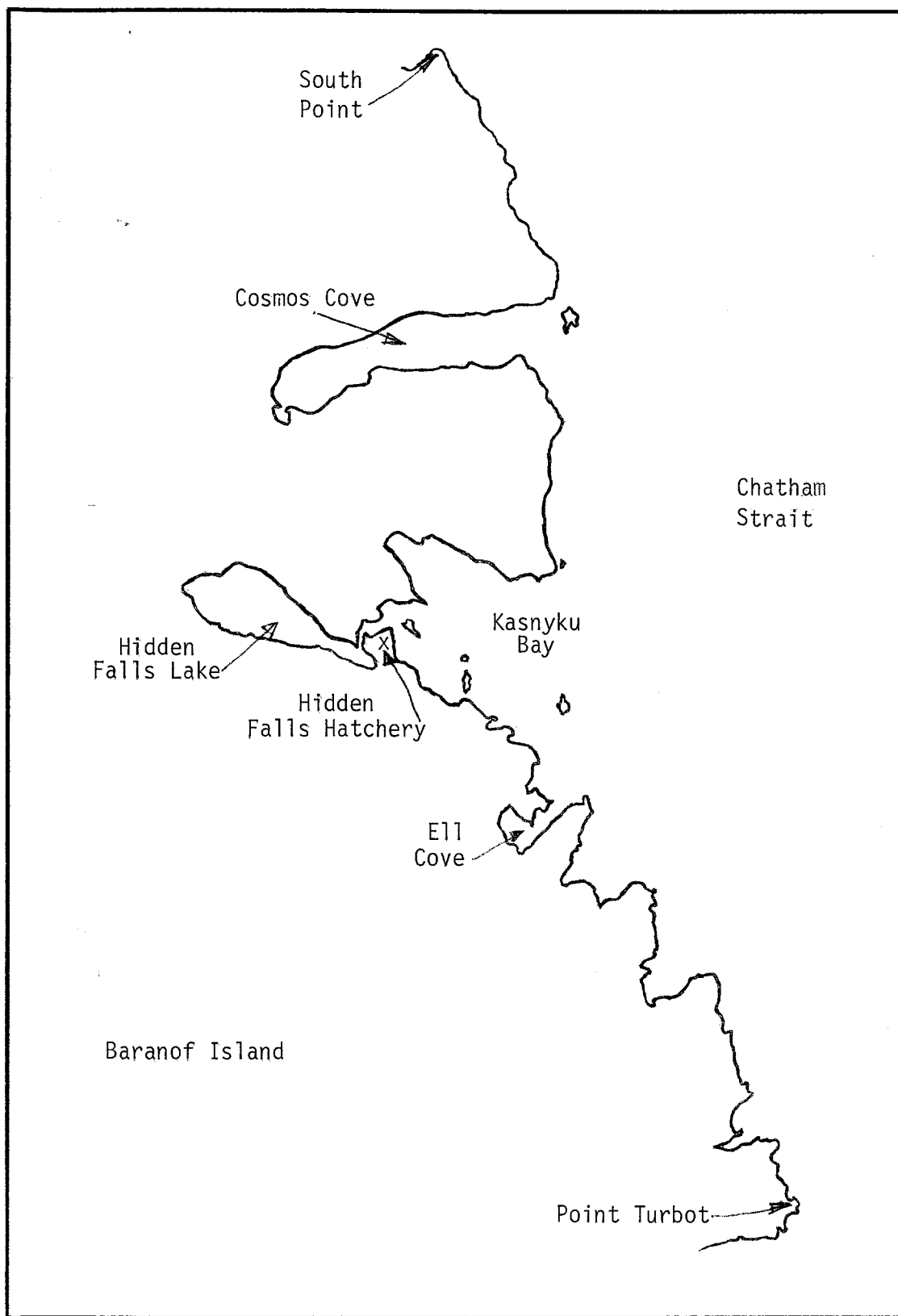


Figure 1. Terminal harvest area for Hidden Falls chum salmon.

The Hidden Falls salmon run in 1984 was especially beneficial to fishermen. An average run would have yielded 165,000 fish: about 27% of the fish actually returning in 1984. The timing was such that the chum salmon returned to the fishery in early July when few fish were available elsewhere. Most other regional seine fisheries had been either disappointingly poor or had occurred later in the season; therefore, the early season fleet effort was concentrated at Hidden Falls.

Comm. Fish. personnel suggested that FRED Division develop a satellite chum fry feeding station in Warm Springs Bay, about 13 km south of Hidden Falls. Staff at this remote station would rear and release a large number of chum fry (possibly up to 30 million). These adult chum salmon, returning 2 to 4 years after release, would home to the Baranof site where all could be harvested. Ideally, this would help spread out the seine fleet and reduce the overcrowded conditions in future Kasnyku Bay fisheries.

Port samplers recovered Hidden Falls tagged chum salmon in six different districts throughout Southeast in 1984. Table 1 shows the number of tags recovered by district. The majority of these tags (94%) were taken from terminally harvested fish. Five tagged fish were caught in southern Southeast gill-net fisheries. One chum salmon that was marked with a spaghetti tag from U.S./Canada marking studies returned to the Hidden Falls raceways on 7 August; the fish had been tagged at Noyes Island (104-40) on 10 July.

#### Hatchery Spawning

At Hidden Falls, over 35 million chum salmon eggs were taken from approximately 32,000 chum salmon. Optimally, 2.25 million eggs were taken daily, filling completely an R48 (1.2 cubic meters) eyeing container. Unripe females were manually sorted during the

Table 1. Numbers of tagged (CWT) salmon caught and areas fished for salmon returning in 1984 to Hidden Falls Hatchery.

<u>District</u>	<u>Tags recovered</u>	<u>Comments</u>
114	9	Port Frederick fishery (Icy Strait)
112-11	883	Kasnyku Bay terminal fishery
112 rest	18	Tenakee Inlet & Northern Chatham Strait
110	8	Frederick Sound
109	10	Lower Chatham Strait
106	5	Clarence Strait (Gillnet fishery)
104	5	Outside Southern Southeast
Total	<u>938</u>	

first 4 days of the egg stripping, but thereafter, the fish were sufficiently ripe to eliminate the sorting process. The fish spawned at a ratio of 1:1 (male to female) but the male to female ratio of the fish returning to the hatchery was very low (0.61:1) when compared to previous years. The average number of eggs taken from each female decreased from 2,180 eggs per female in 1983 to 1,917 eggs per female in 1984 because of the increased speed of the spawning operation. After stripping, about 12,400 excess dark chum salmon were removed from the lagoon by a contractor; 10,000 excess fish were left in the lagoon.

The stripping of eggs began on 1 August, about 1 week later than usual. At Hidden Falls, some of the commercial fishery takes place at the staging area where the fish move into the spawning facility of the hatchery. Because the required numbers of brood stock cannot be secured by hatchery personnel during such a fishery, a large proportion of the total eggs are taken after that fishery has ended. Therefore, the complement of eggs acquired from the spawners is skewed to the last 10% of the run. The 55,000 or so fish that escaped the fishery entered Kasnyku Bay after the last terminal fishery on 23 July (Figure 1). Prior to that date, virtually no fish had escaped the fishery. Plans have been initiated to install a net across the mouth of the net-pen inlet to serve as a brood-stock sanctuary. Prior to the fisheries, enough fish from representative portions of the run would be captured and transferred over the net to serve as broodstock. This plan would preserve a representative percentage of fish from all parts of the run. The net would also maximize the number of fish caught by commercial fishermen and eliminate excess escapement to the hatchery lagoon.

#### Broodstock

A total of 1,669 scales from unmarked chum salmon and 261 scales from marked salmon were read. The age of one marked fish out of 219 that had coded-wire tags was misread, resulting in a 99.5%

accuracy in chum salmon scale aging. The age distribution of adults returning to the hatchery rack was 6.7% 0.2, 90.8% 0.3, and 2.5% 0.4. Average lengths for male chum salmon were 579 mm for age 0.2, 614 mm for age 0.3, and 660 mm for age 0.4. Average lengths for female chum salmon were 579 mm for age 0.2, 608 mm for age 0.3, and 644 mm for age 0.4.

### CWT Results

Two hundred sixty-one heads were taken from adipose-clipped chum salmon, and 219 coded-wire tags were recovered for an overall tag retention rate of 84%. The retention rate was 75% for the 1979 brood, 90% for the 1980 brood, and 92% for the 1981 brood. When grading the quality of clipped adipose fins, 2 out of 19 (11%) grade-2 clips had tags in the heads; the tag retention for grade-2 clips in 1983 was 2 out of 13 (15%), or very similar results. We may want to eliminate questionable clips from future evaluation efforts.

Tag-recovery data were converted to a rate of tags recovered per 10,000 tags released, making varisized release lots comparable. Chum salmon returning from the 1979 brood releases were compared in two ways. The saltwater-reared group (H4-2-6) showed nearly twice the return rate of the strictly freshwater-reared group (H4-2-1). The return rates were 188 vs. 100 tags recovered/10,000 released, favoring the saltwater-reared chum salmon fry. Fry representing the 1979 brood were from eggs taken from the Kadashan (112-42-25) and Clear rivers (112-21-5). These brood sources, tagged separately for comparison, showed no appreciable difference in tag-return rates. Kadashan stock (H4-2-1) had a rate of 100 tags/10,000 released, and Clear River stock (H4-2-5) had a rate of 106 tags/10,000 (Table 2).

The 1980-brood age 0.3 from fry released 15 May (H4-4-5) had six times the CWT return rate of the 15 April release (H4-4-6). The cumulative return rate, including fish of age 0.3 and 0.4, was

Table 2. Numbers of chum salmon reared, marked, released, and recovered from the 1979 Hidden Falls brood.

Fry Releases

Kadashan River (KN)	Salt water reared	1,694,174
	Fresh water reared	1,725,637
Clear River (CR)	Fresh water reared	130,000

All fry released 14 May-20 May, 1980

Tag Code	Brood	Rearing	Size at release (g)	# Marked	Tags recovered						Total
					1982		1983		1984		
					Rack	Fishery	Rack	Fishery	Rack	Fishery	
H4-2-6	KN	saltwater net pens	2.3	10,226	40	3	91	32	5	21	192
H4-2-1	KN	freshwater	1.6	12,914	6	1	65	28	3	26	129
H4-2-5	CR	freshwater	1.4	1,508	1	0	12	1	1	1	16

Freshwater rearing 100 tags recovered/10,000 tags released (H4-2-1)  
 Saltwater rearing 188 tags recovered/10,000 tags released (H4-2-6)  
 Kadashan brood 100 tags recovered/10,000 tags released (H4-2-1)  
 Clear River brood 106 tags recovered/10,000 tags released (H4-2-5)

Tag retention by year of return

1982 47/86 = 55%  
 1983 169/256 = 64%  
 1984 9/12 = 75%  
 overall 1979 brood tag retention 225/360 = 63%

326/10,000 vs. 52/10,000, confirming the 8:1 trend of the same brood last year (Table 3).

Tag recoveries from the 1981 brood returning at age 0.2 were used to evaluate both a late (21 May) release (H4-5-3) and an early (21 April) release (H4-5-0). The preliminary tag-return rates showed a less pronounced effect of the late release over the early release (9/10,000 vs. 5/10,000). More extensive analysis will occur in 1985 (Table 4).

An overall survival rate summary by brood year is shown in Table 5. Fish at age 0.4 completed the 1979 brood returns with a final survival rate of 4.85%. This was the first brood completely incubated, reared, and released at Hidden Falls. The previous two releases (1977 and 1978 broods) had been incubated at Snettisham and then reared in net pens at Hidden Falls for about 1 month.

The returning 1980 brood, not including age 0.4, had an excellent (6.20%) survival rate (Table 6). This table shows the cumulative survival-rate comparison between the two 1980-brood release groups. These include recovered CWT tags, release numbers, and age- class distributions and show the higher survival for fish released late (7.6% vs. 2.78%). The later fish were larger at release than the early fish (2.4 g vs. 1.6 g), which may have influenced survival. Weekly zooplankton samples showed an adequate availability of preferred food items in the estuary, and the water temperatures for the 1981 spring period were warmer than either 1980 or 1982 (McNair and Sele 1982). When compared to the fry released in 1980, these conditions may have contributed to a better survival rate for the fry released in 1981 and may cause a lower survival rate for those released in 1982.

Age-0.2 fish from the 1981 brood returned at a 0.15% rate, which is close to the 0.20% rate of age-0.2 fish from the 1980 brood. The strength of age-0.2 fish currently has no predictive value for

Table 3. Numbers of chum salmon reared, marked, released, and recovered from the 1980 Hidden Falls brood.

Kadashan River (KN) brood origin.

Early release 2,616,981 unmarked fry

Late release 6,396,957 unmarked fry

<u>Tag Code</u>	<u>Lot</u>	<u>Rearing</u>	<u>Release date</u>	<u>Release size (g)</u>	<u>Marked</u>	<u>1983 Rack</u>	<u>Tags recovered</u>		<u>Fishery</u>	<u>Total</u>
							<u>1984 Rack</u>	<u>Fishery</u>		
H4-4-6	KN1	saltwater net pens	15 April, 1981	1.6	29,947	5	4	41	106	156
H4-4-5	KN1	saltwater net pens	15 May, 1981	2.4	30,156	39	34	155	755	983

Early release 52 tags recovered/10,000 tags released.

Late release 326 tags recovered/10,000 tags released.

Tag retention at rack by year of return

1983 44/52 = 85%

1984 196/217 = 90%



Table 4. Numbers of chum salmon reared, marked, released, and recovered from the 1981 Hidden Falls brood.

Kadashan River and Hidden Falls brood origin

Early release 5,106,340 unmarked fry

Late release 5,185,011 unmarked fry

Tag Code	Rearing	Release date	Release size (g)	Marked	Tags recovered		
					1984 Rack	Fishery	Total
4-5-0	saltwater net pens	21 April 1982	1.0-1.2	30,328	6	9	15
4-5-3	saltwater net pens	21 May 1982	0.6-1.8	30,324	6	20	26

Early release 5 tags recovered/10,000 tags released.

Late release 9 tags recovered/10,000 tags released.

Tag retention at rack

Return year

1984 12/13 = 92%

Table 5. Hidden Falls chum salmon survival rate by brood year.

	Number returning by age (% of release)			Return total	No. fry released	Total return %
	0.2	0.3	0.4			
1977 Brood	5	1,855 (0.88%)	1,480 (0.7%)	3,340	212,551	1.57%
1978 Brood	1,576 (.083%)	35,011 (1.85%)	9,105 (.47%)	45,692	1,889,184	2.42%
1979 Brood	21,539 (0.60%)	108,486 (3.01%)	44,418 (1.23%)	174,443	3,599,384	4.85%
1980 Brood	18,262 (0.20%)	540,956 (6.00%)		559,218	9,013,938	6.20%
1981 Brood	14,982 (0.15%)			14,982	10,291,351	0.15%
1977 Brood overall age breakdown	0.2% (0.2)	56% (0.3)	44% (0.4)			
1978 Brood overall age breakdown	1% (0.2)	77% (0.3)	19% (0.4)			
1979 Brood overall age breakdown	12% (0.2)	62% (0.3)	26% (0.4)			

Table 6. Adults returning from the 1980 brood.

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May 15 release tag code H4-4-5 30,156 marked of 6,396,957  
released

1984 returns (0.3)  
rack 38,540  
fishery 431,622  
470,162

1983 returns (0.2)  
rack 4,000  
fishery 12,263  
16,263

Survival rate of late release to date =  $486,425/6,396,957 = 7.60\%$

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April 15 release tag code H4-4-6 29,947 marked of 2,616,981  
released

1984 returns (0.3)  
rack 10,194  
fishery 60,600  
70,794

1983 returns (0.2)  
rack 474  
fishery 1,443  
1,917

Survival rate of early release to date =  $72,711/2,616,981 = 2.78\%$

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Overall 1980 brood return rate through 1984.

$\frac{\text{returned}}{\text{released}} = \frac{559,136}{9,013,938} = 6.20\%$

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estimating the overall survival of any brood (Table 5). The age-class distribution is variable; considerable yearly fluctuation will occur among age 0.2, 0.3 and 0.4. The ratios of returning age-0.3 to age-0.2 fish from the same brood year varies from 30:1 to 5:1 for the 1978 to 1980 broods. Future returns may show useful trends.

### Summary

In 1984 the numbers of chum salmon returning to Hidden Falls Hatchery were much higher than expected. More than 600,000 hatchery fish returned; about 90% of these were caught by commercial seine fishermen (Figure 2). Thirty-five million eggs were taken from the 1984 brood. Utilizing tag recovery, we saw no difference in survival between Kadashan and Clear River stocks. We observed a twofold increase of saltwater-reared fry vs. freshwater-reared fry and a sixfold increase of mid-May released fry over mid-April released fry. The 1980 brood dominated the 1984 returns; age 0.3 comprised 90% of the run. The survival rate for that brood, not including fish of age 0.4 to return in 1985, was 6.2%, or three times the standard-assumption survival rate.

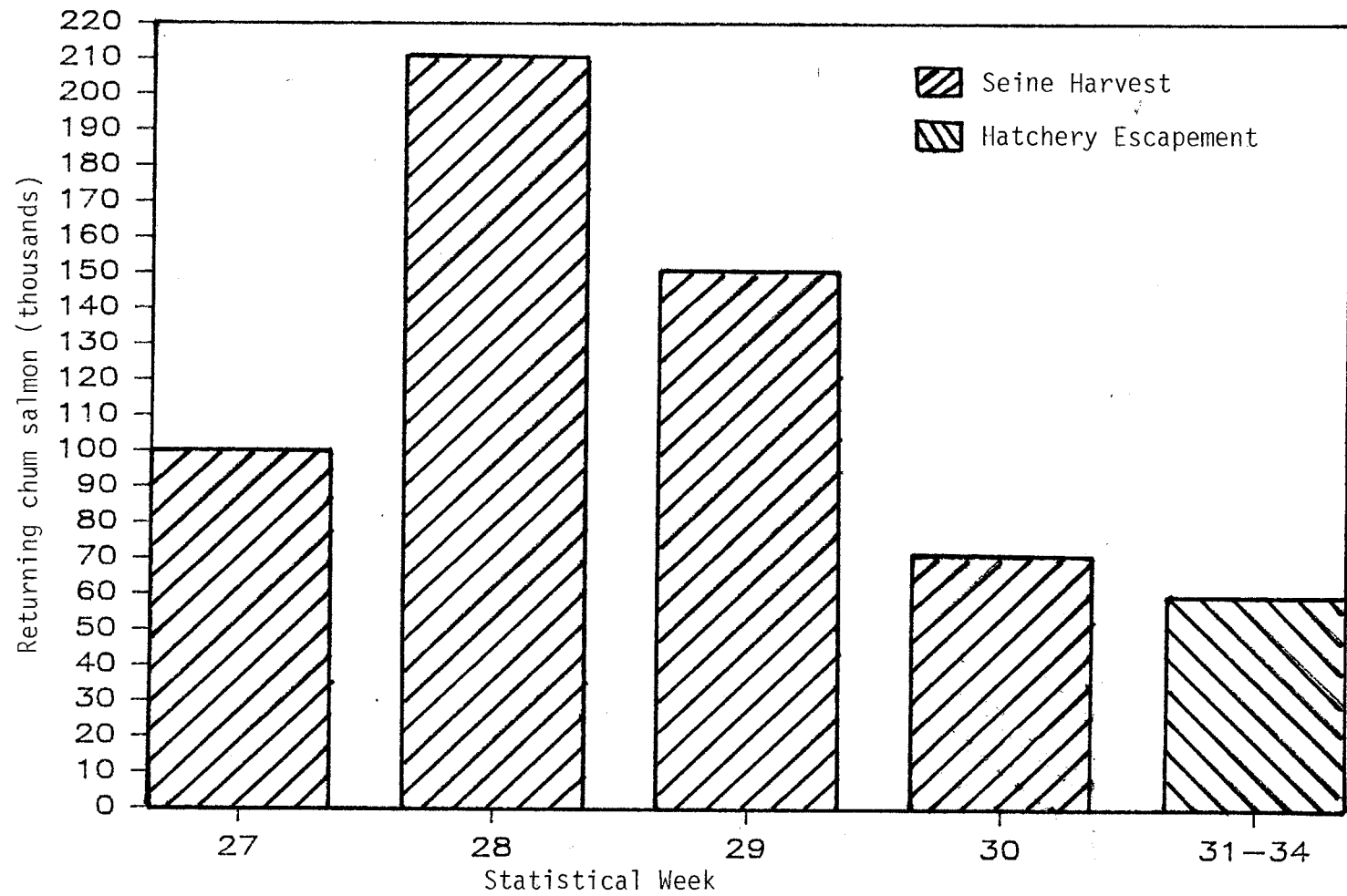


Figure 2. Seine harvest and escapement of adult chum salmon returning to Hidden Falls Hatchery.

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## APPENDIX



Chum Escapement Data - 1984  
Hidden Falls Hatchery

1. # Males killed, not spawned	3,918
2. # Males killed, spawned	8,175
3. # Males carcasses recovered, lagoon	7
4. # Male holding mortality	9
5. Total enumerated male escapement	12,109
6. # Females, killed, not spawned	49
7. # Females spawned	18,746
8. # "Green" females killed	773
9. # "Bad" females killed	295
10. # Female carcasses recovered, lagoon	0
11. # Female holding mortality	24
12. Total enumerated female escapement	19,887
13. Total enumerated hatchery escapement	31,996
14. Male:Female ratio broodstock killed	1:1.64
15. Male:Female ratio overall	1:1.64
16. Female:Male spawning ratio	2:29:1
17. % "green" females killed (does not include excess females)	3.96%
18. % "bad" females killed (does not include excess females)	1.55%
19. % holding mortality	0.10%
20. % female escapement declared excess	0.25%
21. # Ad clips recovered, hatchery	216
22. Estimated number of fish recovered by processor (not including spawned carcasses)	12,400
23. Estimated excess fish left in lagoon and bay (point estimate)	10,000
24. Total escapement to hatchery rack	54,396

(Cochran and Smith 1984)

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